

# Assessment of Sea Otter (*Enhydra lutris kenyoni*) Diet in Kachemak Bay, Alaska (2008-2010)

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## ABSTRACT

Long-term monitoring of a keystone species' diet contributes to our understanding of shifts in the structure of an ecosystem. In Kachemak Bay, the sea otter population recently increased from <1,000 to 3,600. Sea otter diet depends on the habitat type and has been assessed by the following methods: visual observation, scat analysis, and more recently, whisker isotope analysis. Each method has biases. In Alaska, scat collection is feasible in winter months when sea otters haul-out in greater concentrations. In this study we evaluate scat analysis as a low-cost tool to monitor long-term trends in the winter diet for sea otters in Kachemak Bay.

Dominant prey types at all sites were mussel (41%), crab (32%), and clam (12%). There was an inverse relationship between the proportions of mussel (dominant late fall/spring) and crab (dominant winter/early spring) in the diet. Scat analysis is biased toward species where hard parts of prey are ingested. In summer 2008, visual observations of foraging otters were conducted (n=322 successful dives) and dominant prey types were clam (38%), mussel (14%) and crab (2%). Shells of large clams were discarded rather than ingested. Kachemak Bay is primarily a soft-sediment habitat with the potential to support large populations of high-calorie sea otter prey, such as large clams and crabs. Commercially valuable crab species were historically abundant in this area. Scat analysis will be a useful tool in identifying trends in winter consumption of crab and mussel, but will exclude identification of larger bivalve and soft-bodied prey.

**Key Words:** Alaska, *Enhydra lutris*, habitat, prey choice, scat

## INTRODUCTION

Sea otters eat a wide range of marine invertebrates and their diet varies by the type of forage habitat available to them. The relationship between sea otter foraging and ecosystem structure has been best studied in habitats which are urchin and kelp dominated (Estes and Palmisano 1974, Simenstad et al. 1978; Duggins 1980). Less is understood about prey and ecosystem dynamics in soft-sediment habitats where dominant prey tend to be clams and crab (Kvitek and Oliver 1988; Kvitek et al. 1992; Doroff and DeGange 1994). Kachemak Bay, Alaska, is primarily a soft-sediment basin where the sea otter population increased from <1,000 in the 1990s to 3,600 in 2008 (Gill et al. 2009). Methods for assessing sea otter diet include visual observation (Doroff and DeGange 1994), scat analysis (Doroff and Bodkin 1994; Watt et al. 2000), and, recently, emerging techniques in whisker isotope analysis (Newsome et al. 2009). All methods have some biases in identification of sea otter prey. In this study we evaluate the results of sea otter diet determined by scat analyses and visual observations and assess scat analysis as a low-cost tool to monitor long-term trends in the winter diet for sea otters in Kachemak Bay.

## MATERIALS AND METHODS

**Scat Collection:** Scat collection is limited in our study area to the winter months when sea otters haul-out more frequently and in greater concentrations (Doroff and Badajos 2010, pers. observation). In March 2008 we began a pilot study to assess the feasibility of determining sea otter diet by scat collection in Kachemak Bay. Nine locations were assessed, and of those, a site in Little Tutka Bay where sea otters (females, females with pups, and an occasionally territorial male) haul-out on floating docks was selected as a long-term monitoring location (Fig. 1). The site in Little Tutka Bay was chosen because we could reliably visit the site throughout the winter months on a weekly basis. Lack of funding precluded monitoring a more broad geographic range of potential haul-out sites. In Little Tutka Bay, both sea otter and river otter (*Lontra canadensis*) scats were collected. During October – May 2008, 2009, and 2010, we searched for and collected scat samples from one week accumulations at approximately monthly intervals (Table 1). All scats were collected, labeled with the date and location, and frozen until processing.

**Visual Observations:** We conducted visual observations in a female/pup area in proximity to the long-term monitoring site for scat collection during summer 2008 (Fig. 1). Lack of funding precluded the collection of visual observations of foraging sea otters during the winter months. Focal animal sampling was used to select study animals and all visual observations were conducted with a high-power telescope (Questar field model 50x). Methods followed previously established protocols for visually identifying prey and estimating prey size (Doroff and DeGange 1994; Doroff and Bodkin 1994).

**Scat Sample Processing:** Scat samples were washed with fresh water through a high-pressure hose using one large mesh (2mm) and one fine screen ( $\leq 1\text{mm}$ ) sieve. Air dried samples were sorted by hand to the nearest discernable taxonomic level and placed in Ziploc baggies for analysis. The relative importance of each prey type was determined by the frequency of occurrence and the percent volume for each sample. The frequency of occurrence was expressed as the presence of a prey type in a scat. The percent volume of each prey type was estimated and ranked as follows, using a 1-6 index method where: 1 =  $<5\%$ , 2 = 5-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 =  $>95\%$ . We ranked each prey type which occurred in the scat. To summarize mean percent volume, we used the median value of each category.

## RESULTS AND DISCUSSION

During 2008 (March, April, and May), we collected 147 scat samples from 9 locations throughout the Bay. During October 2008 – May 2009 and December 2009 – April 2010, we collected 97 and 20 scat samples, respectively, at our long-term monitoring site in Little Tutka Bay (Fig. 1). Dominant prey types in the scat samples at all sites were mussel (*Mytilus trossulus*) (41%), crab (32%) (including: *Cancer spp.*, *Telmessus cheiragonus*, *Pagurus spp.* and probable *Chionoecetes bairdi*), and clam (12%) (including: *Saxidomus giganteus*, *Mya spp.*, and *Leucoma staminea*). Other species present throughout the sampling period included urchins (*Strongylocentrotus spp.*), chitons, limpets (*Tectura spp.*), and snails (Table 2). In most cases, the prey was well masticated and we were not able to identify the remains to species. Though not previously known to be sea otter prey in Kachemak Bay, we found fish bones in scat collected during the winter sampling periods in 2008 and 2009. Fish bones were usually only one or two rib bones and never a whole fish; fish bones comprised  $<1\%$  of the total volume of

any single scat (Table 2). Sea otter haul-out sites in our study area were shared with river otters (*Lontra canadensis*), so it is possible that the fish bones could have been originally part of the river otter scat. The river otter scat collected has not been analyzed for species content. We also collected 10 scats that were not identified species; possible species include American mink (*Neovison vison*) and bear (*Ursus americanus*).

The mean number of prey types per scat sample across all locations and sample periods was 4 (n= 264; range 1-10). There were no marked differences in trends in composition or prey diversity (number of taxon per scat) among sites sampled in spring 2008 and the long-term monitoring site sampled in winters 2008-2009 and 2009-2010 (data were combined). For all years, there was an inverse relationship between proportion of mussel (dominant late fall and spring) and crab (dominant winter and early spring) in the diet. Proportions of clam, urchin, and other prey in the scat samples fluctuated but remained at low levels ( $\leq 20\%$ ) throughout the sampling period (Fig. 2).

Diet assessed by visual observation in 2008 (n=322 successful dives) indicated the dominant prey type in sea otter diet was clam (38%); mussel and crab were 14% and 2% of the total sample, respectively. Size classes were estimated for 230 clams retrieved as sea otter prey and the median size class consumed ranged from  $> 3\text{cm}$  to  $\leq 5\text{cm}$ ; shells were discarded rather than ingested. Based on visual observation, shells from most clams consumed would not have been in the scat record for foraging sea otters. Mussels were a much smaller part of the diet and are consumed by all sex and age classes of sea otters. In general, mussels are easy for sea otters to capture but are a lower-calorie prey per food item than larger bivalves. As a result, young-of-the-year tend to have a higher portion of mussels in their diet than adults (Doroff and Bodkin 1994). From a scat analysis viewpoint, mussel shells are ingested every time they are foraged on and will be identifiable in the scat sample whereas clams will only be detected when the smallest size classes or clam species with soft shells (such as *Mya* spp.) are consumed.

Kachemak Bay is a large fjord estuary and supports the only significant commercial and recreational clam fisheries in Southcentral Alaska, as well as a personal-use Tanner crab (*Chionoecetes bairdi*) fishery. The habitat is largely soft-sediment and has the potential to support large populations of high-calorie sea otter prey, such as clams and crabs. During 2007-2010, the U. S. Fish and Wildlife Service and the Kachemak Bay Research Reserve conducted a study of survival, movements, and habitat use of 44 radio-marked sea otters in Kachemak Bay (Doroff and Badajos 2010). Figure 3 illustrates the cumulative distribution of winter (Oct-Apr) foraging locations for all sex and age classes of study animals. Assuming that marked animals were representative of the whole population, foraging occurred near haul-out sites, as well as in open water. To begin to understand relationships between sea otter foraging and the benthic ecosystem in Kachemak Bay, multiple methods will need to be employed. Scat analysis is strongly biased toward ingested hard parts of prey and, in the case of clams, understates the contribution of larger sized clams in the diet. In contrast, visual observations are limited to the nearshore foraging habitat and are biased against prey consumed  $> 1\text{km}$  from shore, which may include larger species of crab. Because of biases in both visual observation methods, and in scat analyses to accurately determine sea otter diet, emerging techniques in isotope studies of sea otter whiskers will likely be an important tool in understanding diet in habitats like Kachemak Bay (Newsome et al. 2009).

## **CONCLUSION**

Scat analysis will be a useful tool to identify trends in specific prey, such as crab, in Kachemak Bay over time. Crab parts, even those that are well-masticated, are identifiable in the scat samples and include a range of species from small intertidal and subtidal species to larger Tanner crabs. We are currently developing an identification manual for the crab species which occur in Kachemak Bay sea otter scats during the winter months. This type of diagnostic tool would positively impact the efficiency of monitoring the trend in crab consumption over time, both within a season and among years. Human use of crab in the study area is managed by the Alaska Department of Fish and Game. A better understanding of the effects of both human use and of a keystone species foraging on crab populations will facilitate comprehensive management of harvestable crab species.

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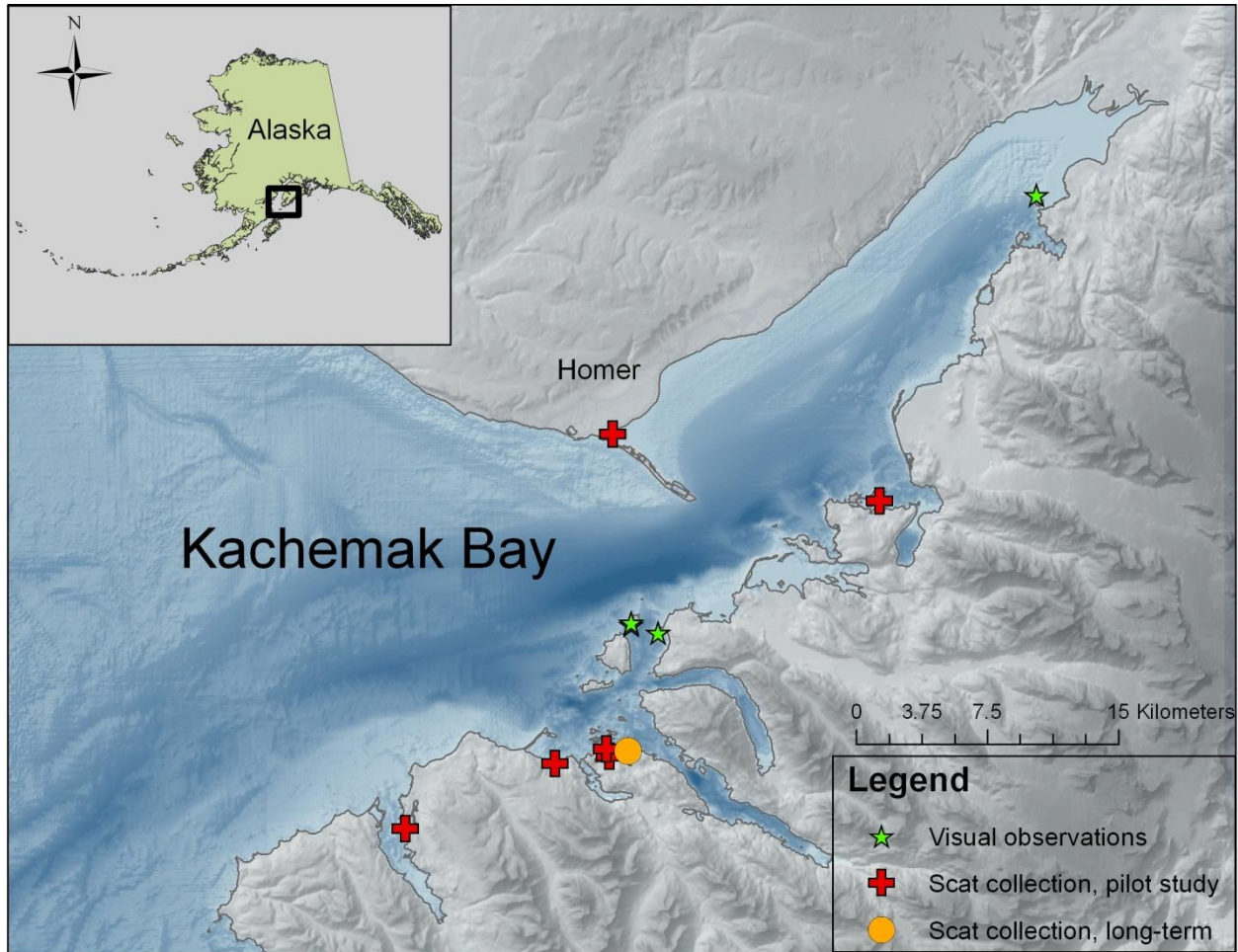


Figure 1. The study area is located in Kachemak Bay, Southcentral Alaska. In March 2008 we began a pilot study to assess the feasibility of determining sea otter diet by scat collection in Kachemak Bay (red). Nine locations were assessed, and of those, a site in Little Tutka Bay where sea otters haul-out on floating docks was selected as a long-term monitoring location (orange). Diet was assessed by visual observation in 2008 at three locations (green).

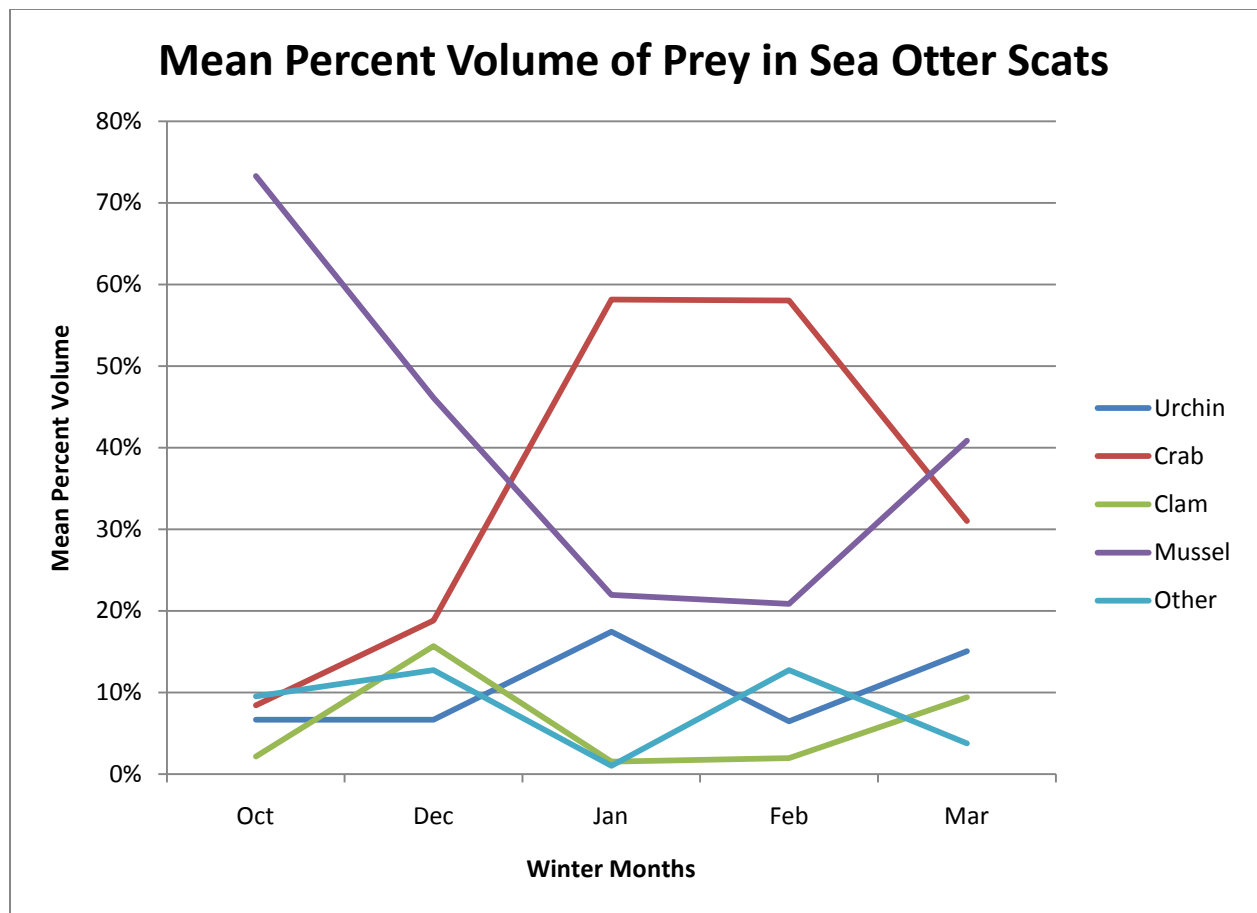


Figure 2. Mean percent volume of prey in sea otter scats collected in Kachemak Bay, Alaska for all sites combined across all years (spring 2008, fall 2008-spring 2009, and fall 2009-spring 2010).



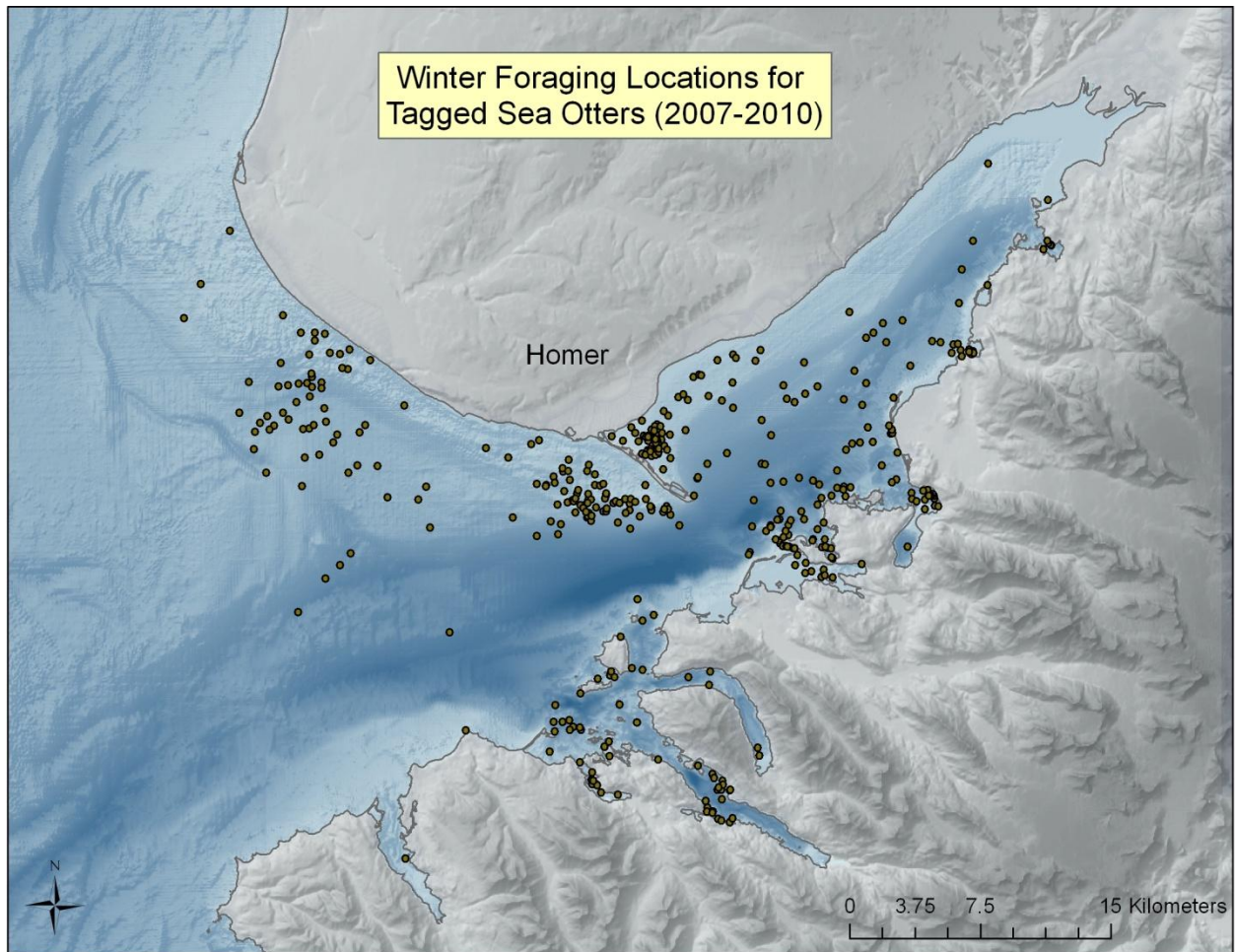


Figure 3. Cumulative distribution of winter foraging locations (October – April) of 44 tagged sea otters in Kachemak Bay, Alaska during 2007- 2010 (n=414).



**Table 1.** Sample sizes for scat collected from sea otter and river otter at multiple locations in Kachemak Bay, Alaska in the spring of 2008, and monthly during the fall of 2008-2010. A dashed line indicates that the study site was not checked during that month.

Month	2008		2009		2010	
	Sea Otter	River Otter	Sea Otter	River Otter	Sea Otter	River Otter
Jan	--	--	--	--	6	0
Feb	--	--	9	0	3	0
Mar	24	0	8	0	2	0
Apr	55	5	10	0	1	0
May	68	3	32	0	0	0
Jun	--	--	0	0	0	0
Jul	--	--	0	0	0	0
Aug	0	9	0	0		
Sept	0	4	0	0		
Oct	18	9	0	0		
Nov	--	--	--	--		
Dec	20	1	8	0		

**Table 2.** Frequency of occurrence and the mean percent volume of prey types in sea otter scat samples collected at haul-out sites in Kachemak Bay, Alaska 2008-2010

Prey Type	% Freq Occurrence			Mean % Volume		
	Spring 2008 (n=147)	Fall 2008- Spring 2009 (n=97)	Fall 2009- Spring 2010 (n=20)	Spring 2008 (n=147)	Fall 2008- Spring 2009 (n=97)	Fall 2009- Spring 2010 (n=20)
Mussel	94	93	70	41	42	33
Crab	80	80	85	31	29	52
Clam	59	61	40	12	12	8
Barnacle	39	37	0	2	2	0
Urchin	38	42	25	6	11	6
Snail	20	26	0	1	2	0
Limpet	18	15	0	1	1	0
Chiton	13	8	5	1	0	0
Unid. Bivalve	5	11	0	1	0	0
Scallop	5	9	0	0	0	0
Unid. Prey	4	11	15	0	0	0
Fish	3	10	0	0	0	0
Horse mussel	3	2	0	0	0	0
Shrimp	1	0	0	0	0	0
Worm	0	1	0	0	0	0
Cockle	0	5	0	0	0	0
Sand dollar	0	1	0	0	0	0